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ARE FISCAL AND MONETARY POLICIES REFLECTED IN REAL YIELDS? EVIDENCE FROM A PERIOD OF DISINFLATION AND DECLINING DEFICIT TARGETS *

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We examine the effect of monetary and fiscal policies on yields on short- and long-term *indexed* bonds, in view of the crucial importance of these yields for economic activity. We extend the current literature dealing with the same question by providing evidence about a period in which the government adopted declining inflation and fiscal targets. In such cases the policy shift could be perceived as having implications in the long run and therefore may effect long-term as well as short–term yields. The fact that most government bonds in Israel are CPI-indexed allows us to use the real yields for the various terms directly, without having to decompose nominal yields into a real component and inflation expectations, as is the case with the data for other countries. Our main finding is that fiscal and monetary policies do affect short– and long-term yields. We find that a rise of one percent in the expected deficit/GDP ratio (cyclically adjusted) increases the long-term interest rate by 0.2 percentage points, i.e., Ricardian equivalence does not obtain fully. Another finding is that fiscal policy has a slightly greater effect on long-term yields than on medium- and short-term yields. In addition, changes in the government's deficit targets affect long–term yields. With regard to the effect of monetary policy, the longer the term of bonds, the weaker is the effect on yields, although the effect on long-term yields is by no means inconsiderable. A one-percentage-point rise in the central bank's key interest rate (in real terms) serves to increase the yield on one-year bonds by 0.8 percentage points, and the yield on 10-year bonds by 0.3 percentage points. Part of the significant long-term influence of monetary policy stems from its direct effect on the long-term component of yields—which we isolate in this study (the forward component). Our results are best interpreted as evidence for a long-term effect of monetary policy during a (credible) disinflation process. We also find that in the wake of financial liberalization and the greater openness of the economy, the US interest rate has come to affect the yields on domestic bonds, albeit less significantly than expected in a fully open economy.

1. INTRODUCTION

The present study focuses on analyzing the effect of fiscal and monetary policy and interest rates abroad on Israel's capital market. We examine whether the government deficit (current

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or forecast), changes in deficit targets (which were frequent in the last decade), the size of the government debt (as a share of GDP), and monetary policy influenced the yields on bonds during the 1990s. We also endeavor to ascertain whether monetary policy was directly or indirectly affected by fiscal policy, and if—and to what extent—yields abroad impacted on domestic bond yields.

This study contributes to the literature on the subject in three ways: first, it focuses directly on real yields for different terms, without having to decompose nominal yields into a real component and inflation expectations, as is required for other countries' data and has been done in many studies. This is possible because a large proportion of tradable government bonds in Israel is indexed to the CPI (Consumer Price Index). Second, this study separates the effect of policies on the forward component of the long term yields from the effect on the short end of these yields. Third, we examine the effect of fiscal and monetary policy at a time when declining deficit and inflation targets were adopted, when current policy may have a greater impact by signaling the policy makers' long-term behavior.

As stated, the relation between fiscal and monetary policy and yields in the money market has been examined in many theoretical and empirical studies, as well as in various episodes world wide when money market interest rates were high and the government deficit rose (e.g., the US in the early 1980s), and vice versa (e.g., the US since the mid-1990s). There is a long-standing dispute in the theoretical and empirical literature with regard to the effect of fiscal policy on domestic interest rates. Whereas according to the Keynesian and neo-Keynesian approach a larger deficit will cause interest rates to rise (Modigliani, 1961; Blinder and Solow, 1973), the Ricardian Equivalence theory (Barro, 1974) contends that an increase in the government deficit, which is perceived by the public as permanent, will not affect interest rates (see below).[1] Furthermore, studies undertaken in the last decade have suggested that expansionary fiscal policy could even moderate aggregate demand by impacting on productivity, and hence on the demand for investment and consumption on top of the Ricardian effect (Alesina, Perotti and Tavares, 1998). In that case, fiscal expansion could even cause long-term interest rates to fall.[2] Another approach stresses the importance of international capital mobility, claiming that in an open economy fiscal policy will not affect interest rates (Mundell, 1963), except indirectly through its influence on the risk premium. The empirical findings regarding the impact of the deficit on interest rates in general are also not unequivocal: in some countries no relation was found between the fiscal variables and market interest, i.e., the Ricardian Equivalence approach was borne out, while in others or at other times a relation was found between the fiscal variables and yields, as shown below.

There is considerable empirical evidence from various countries for the effect of fiscal policy on yields but, as stated, this is not always unequivocal. Empirical studies which found no relation between fiscal policy and interest rates include those of Plosser (1982), Mehra (1994), Evans (1987), Siklos (1988), Modigliani and Jappelli (1988), and Barro and Sala-i-Martin (1990). Faini (2004) finds that fiscal balances do affect interest rates and that their impact is much stronger at the aggregate EMU level than at the separate national level. Other studies found a relation between fiscal variables and yields, including those of Turnovsky and Miller (1984), Kitchen (1996), Wachtel and Young (1987), Thorbecke

[1] Nevertheless, other studies argue against some of the assumptions underlying this theory, concluding that a relation can be expected between fiscal policy and interest rates. For a comprehensive review of the literature on Ricardian Equivalence, see Seater (1993).

[2] The article by Alesina, Perotti and Tavares (1998) contains indications that long-term interest rates have risen in the wake of significant (and credible) deficit reductions.

(1993), Knot and de-Haan (1995), Caporale and Williams (2002), and Hoelscher (1986). Some, such as Barro (1981) and Turnovsky (1989), make a distinction between temporary and permanent deficits, claiming that only the latter will affect yields. An extensive review of this literature presented by Gale and Orsag (2002) stresses that the failure to establish a clear-cut relation between fiscal policy and yields derives from differing definitions of current vis-à-vis expected policy. They assert that almost all the studies of the effect of expected (rather than actual) deficits indicate that a rise in the deficit has a significant effect on long-term interest rates. Laubach (2004) also stresses the importance of measuring correctly the expected future deficit. According to a selective review of empirical evidence he presents, studies that use good measures of the expected deficit tend to find strong evidence that deficits raise interest rates. Some studies examine the influence of the government debt on yields, but their theoretical conclusions are not clear, and their empirical findings do not support the existence of a positive relation between changes in the size of the public debt/GDP ratio and interest rates. In effect, Caporale and Williams (2002) find a negative or non-significant relation between the variables for most countries, as do Knot and De-Hann (1995). In a cross-sectional international study, on the other hand, Lane (1993) discerns a positive relation between interest rates and the public debt/GDP ratio, attributing this to the country risk premium.

Many studies have tackled the question of the relation between monetary policy and interest rates as part of a wider literature dealing with the economic effects of monetary policy. The main conclusion of these studies is that monetary policy affects the economy in the short run (e.g., via the negative correlation between inflation and unemployment, in accordance with the Phillips curve), while in the long run its effect on the economy is nominal rather than real (the neutrality of money). The fact that monetary policy has an effect in the short run does not mean that it will not also find expression in long-term (e.g., ten-year) yields, especially since long-term interest rates are an average of the expected short-term ones for the remaining term of the bond (as is stressed in expectations theory regarding the yield curve). In this context, we examine whether, due to the adoption of inflation targets, changes in short-term interest rates signal to the public that the intention is to keep rates high for a long time, thereby influencing long-term yields, and especially their distant (forward) component.

The theoretical and empirical approach adopted here follows and expands the one presented by Sargent (1969), according to which yields in the money market have two components: the steady-state equilibrium interest rate, which is determined by the supply of savings and the demand for investment (in a closed economy), and the deviation from that rate, which may be the outcome of monetary policy. In our theoretical formulation we expand that approach, enabling private saving to respond to changes in public saving—in accordance with Ricardian eqivalence. Concurrently, we enable investment to react to the government deficit, in line with studies which focus on the restraining effect of expansionary fiscal policy. We also extend the model to a partly open economy in which sources of saving include capital flows, which are determined by interest rates abroad. From the formulation of a general equilibrium we derive a reduced-form equation of market yields on bonds, in which the main explanatory variables are fiscal policy, monetary policy, changes in GDP, and interest rates abroad. In addition to estimating the factors impacting on overall yields, we estimate equations in which the dependent variable is the forward yield given the various interest rates.[3] This addition is important for isolating the effect due to the short end from

[3] For example, the expected interest rate for the sixth to the tenth year on 10-year bonds.

the long-term yields, making it possible to gain a better understanding of the transmission mechanism between the explanatory variables and long-term interest rates.

We then examine the extent, if any, to which fiscal policy affects monetary policy, thereby indirectly influencing yields in the money market. The motivation for undertaking this test arises from recent studies (Woodford, 2001; Canzoneri and Diba, 2002), according to which attaining a price-stability target, which is the target of monetary policy, requires appropriate fiscal policy.

We find that both monetary and fiscal policy affect money market yields. Monetary policy has a direct influence on long- and short-term yields. The dominance of monetary policy, as is indicated by this study, may be due to the disinflationary policy implemented in Israel in the last decade and unique to that period. Fiscal policy impacts directly on money market yields via the expected deficit and the deficit targets, and indirectly through the effect on inflation expectations and hence on monetary policy.

The article consists of five sections. In the following section we present the theoretical framework of the research. In Section 3 we describe the data and review briefly Israel's monetary and fiscal policy. The estimation and the results are presented in Section 4, and the conclusion is given in Section 5.

2. A CONCEPTUAL FRAMEWORK FOR EXAMINING THE FACTORS AFFECTING BOND YIELDS

We adopt Sargent's (1969) conceptual framework, according to which the money market yields on government bonds can be decomposed into two components: the ex ante equilibrium interest rate at which the saving rate is in balance with the demand for investment, according to the economy's fundamentals (defined here as 'basic equilibrium'). This component cannot be observed directly, but is influenced by observable economic factors which affect the demand for investment (both domestic and abroad) as well as the supply of savings, and especially by fiscal policy. The other component of market interest is the deviation from this rate due primarily to monetary policy (the loanable funds model). This framework enables us to examine the effects of fiscal and monetary policy on money market yields.

We extend Sargent's model in several respects: we adapt it to real rather than nominal yields (in view of the large share of CPI-indexed government bonds in Israel), and adjust it to the possibility that Ricardian equivalence exists, i.e., that private savings will respond to a change in the government deficit; to the possibility that fiscal policy will have a restraining effect on domestic investment; and also that interest rates abroad can exert an influence if the economy is open to capital flows.

The money market yield on government bonds (Rm(t)) can be described as follows:

$$(1) \qquad R_{m(t)} = R_{e(t)} + [R_{m(t)} - R_{e(t)}]$$

where the first element in the equation is the basic equilibrium interest rate, and the second describes the possible difference between market yields and basic equilibrium yields. The basic equilibrium interest rate is the one at which the saving rate, including government saving and capital inflow, is equal to the demand for investment (all the saving and investment variables are expressed as percentages of GDP).

The investment demand equation can be written as an "accelerator model," in which investment I is positively dependent on a change in GDP, (Δy) (see, e.g., Mehra, 1994), and negatively dependent on the interest rate. Investment could also depend on the

economy's demographic structure (Demog), which influences the demand for residential and nonresidential investment. In Israel, in particular, the influx of immigrants in the early 1990s had a significant impact on the extent and timing of residential and nonresidential investment. In addition, as stated, investment could be (positively) contingent on public saving (SG) if it affects productivity. Note that I is demand for investment, not actual investment (which includes involuntary inventory investment), as otherwise equation (5) below would be an identity.

$$(2) \qquad I_{(t)} = g_0 + g_1 \Delta y_{(t)} + g_2 Demog + g_3 R_{e(t)} + g_4 SG_{(t)}$$

Private saving (SP) depends positively on the interest rate, and negatively on public saving. The extent to which public saving affects the behavior of individuals reflects their level of Ricardian behavior:[4]

$$(3) \qquad SP_{(t)} = s_0 + s_1 R_{e(t)} + s_2 SG_{(t)}$$

Capital inflows (FF) depend positively on the difference between the real domestic interest rate and that abroad, Rf, assuming that the economy is not completely open to capital flows, so that interest-rate differences may exist. If the economy is completely open to capital flows the domestic interest rate will be the same as that abroad, and the other variables will not affect it:

$$(4) \qquad FF_{(t)} = f_0 + f_1 (R_{e(t)} - R_{f(t)})$$

and at equilibrium, the following should obtain:

$$(5) \qquad SP_{(t)} + SG_{(t)} + FF_{(t)} = I_{(t)}$$

Equality between saving and the demand for investment will determine the basic equilibrium interest rate. Solving equation (5) yields:

$$(6) \qquad R_e = \frac{1}{(s_1 + f_1 - g_3)} [(g_0 - s_0 - f_0) + g_1 \Delta y + g_2 Demog + SG(g_4 - s_2 - 1) + f_1 R_f]$$

The basic equilibrium interest rate is positively influenced by a rise in GDP, which increases the demand for investment. A higher interest rate abroad will be expressed in a higher domestic rate, to the extent that the economy is open to capital flows, denoted by the coefficient f1. A decline in government saving (a rise in the deficit less government investment), which increases the government's demand for sources, will influence domestic interest rates in line with the sensitivity of saving and investment to changes in the government's behavior.

The second component of market yields depends on monetary policy. Tight policy, expressed in higher short-term rates, will contribute to a rise in real market yields, and can be written as follows:

[4] Our discussion of the Ricardian equivalence assumes that the public perceives changes in public saving as permanent. In our empirical analysis we attempt to construct proxies for the permanent level of government saving. If changes in government saving are understood as transitory, their effect on private saving may be different.

$$(7)\quad R_m - R_e = k_0 + k_1 R_{MON}$$

where RMON is the monetary interest rate set by the central bank in real terms.

All in all, the reduced form of the yield equation can be written as being contingent on the following factors:

$$(8)\quad R_m = a_0 + a_1 \Delta y + a_2 Demog + a_3 SG + a_4 R_f + a_5 R_{MON}$$

where

$$a_0 = \frac{(g_0 - s_0 - f_0)}{(s_1 + f_1 - g_3)} + k_0, \quad a_1 = \frac{g_1}{(s_1 + f_1 - g_3)}, \quad a_2 = \frac{g_2}{(s_1 + f_1 - g_3)},$$

$$a_3 = \frac{(g_4 - s_2 - 1)}{(s_1 + f_1 - g_3)}, \quad a_4 = \frac{f_1}{(s_1 + f_1 - g_3)}, \quad a_5 = k_1$$

The denominator in the a0 to a4 coefficients is positive as its first two components are positive, and the third (the effect of the interest rate on demand for investment) is negative. The a1 coefficient is expected to be positive, in line with the sign of g1. The size and sign of a3, the coefficient of government saving, depends on the extent to which private saving and investment respond to a change in government saving. If full Ricardian equivalence exists ($s_2 = -1$), private saving adapts, so that there is no change in total demand, and hence the interest rate is not expected to change if investment does not respond to government behavior ($g_4 = 0$). In that case a3 is expected to be zero. If investment rises as government saving increases, because of expectations of faster growth ($g_4 > 0$), and there is full Ricardian equivalence, the coefficient is positive. In all other cases the relative intensity of the response of private savings (and investment) to the size of public savings will determine the size of the coefficient.[5] The extent to which the economy is open to capital flows is expressed by the coefficient a4. In a completely open economy, where interest rates are determined on the basis of interest abroad (i.e., f1 tends to infinity), we will expect to obtain $a_4 = 1$ while all the other coefficients converge to zero.[6] The coefficient of monetary policy is expected to be positive, but its size will depend on the nature of the transmission mechanism between the interest rate set by the central bank and the market yield for longer term bonds.

3. POLICY OVERVIEW AND DESCRIPTION OF DATA

Our research focuses on the 1990s, using monthly data for the period from August 1991 to the end of 2001. Several factors characterize the sample period. The policy setting was changed to include deficit and inflation targets.[7] Furthermore, tradable bonds accounted for a relatively small proportion of total government debt (which also includes nontradable bonds) until the mid-1980s; only in 1990, did they reach 50 percent. Furthermore, the government

[5] The coefficient s_2 may fluctuate, thereby reflecting a risk premium that rises as public saving contracts.

[6] If the economy's risk premium depends on the other factors in the equation, their coefficient may differ from zero.

[7] In addition, monthly reporting of government activity began only in 1990.

used administrative measures to intervene in the capital markets. In other words, the market had not previously played a significant role in determining yields before the 1990s.

The market for CPI-indexed bonds, from which the yields examined in this study are derived, constitutes a vital component of the domestic capital market. In December 2001 the stock of tradable government bonds was about 40 percent of GDP, with CPI-indexed bonds accounting for about 50 percent of this.

An examination of short- and long-term yields shows that throughout most of the 1990s there was a trend rise in (real) yields on bonds for all horizons (Figure 1). This trend characterizes all horizons, although with varying intensities, so that the relation between yields and horizons, which may be represented by the yield curve, changed in the course of the decade.

Figure 1
Real yields on 1-Year and 10-Year CPI-Indexed Bonds, 1987–September 2002

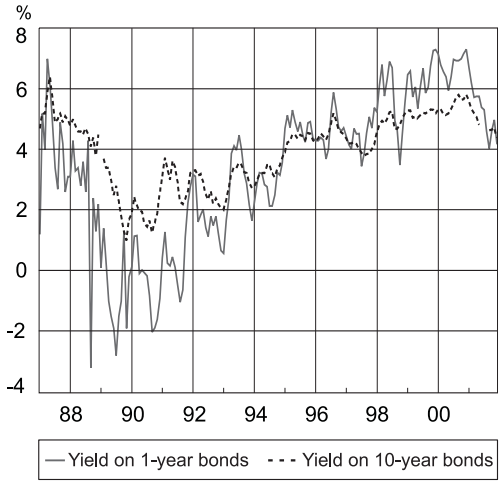


Table 1 gives the yield for bonds of varying terms. Two notable characteristics emerge. First, the average yield is very similar for all horizons. Second, the longer the horizon, the smaller the standard deviation over time. This result is expected if we assume that long-term yields are the weighted average of expected future short-term interest rates.

Table 1
Main Statistics on Bond Yields, 1990–June 2002

Horizon (years)	1	3	5	10
Mean	3.74	3.86	3.87	3.96
Standard deviation	2.30	1.74	1.47	1.15
Maximum yield	7.32	6.89	6.53	5.82
Minimum yield	-2.02	-0.49	0.34	1.26

Table 2, which gives the correlations between the change in yields at different horizons, shows that the correlation is relatively high, but declines as the difference between terms increases.[8]

Table 2
Correlation Between Change in Yields at Different Horizons, 1990–June 2002

	1	3	5
3	0.88		
5	0.84	0.92	
10	0.67	0.75	0.84

Since we are interested in isolating the effect of policy on the long-term part of yields, we also calculated future yields for various terms. The main statistics are given in Table 3.

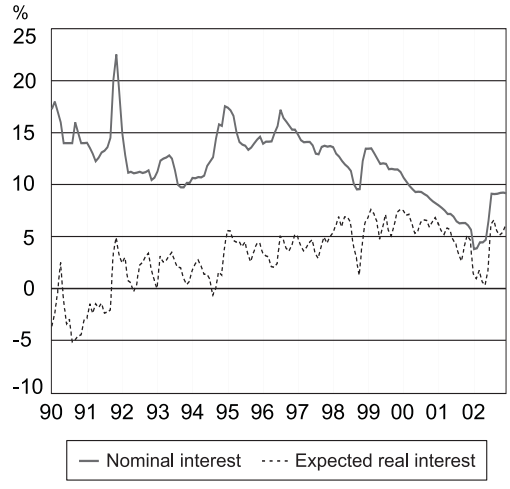
Table 3
Main Statistics on Future Bond Yields, 1990–June 2002

Horizon (years)	1	2-3	4-5	6-10
Mean	3.74	3.92	3.87	4.05
Standard deviation	2.30	1.49	1.13	0.92
Maximum yield	7.32	6.87	6.01	6.41
Minimum yield	-2.03	0.30	0.98	1.93

3.1 Monetary policy

We present the effect of monetary policy by means of the real interest rate, which is obtained from the difference between the central bank's nominal interest rate—which was the central bank's principal monetary instrument in the period reviewed—and inflation expectations derived from the capital market. We also estimate the same equations using both the bank's nominal interest rate and inflation expectations instead of the real interest rate. As Figure 2 shows, from the end of 1993, and more clearly from the end of 1994, the central bank's interest rate was raised in order to reduce inflation and achieve the declining inflation targets that were announced since 1993.

Figure 2
Central Bank Interest Rate, in Nominal and Real Terms, 1990–2002



[8] The correlation between the levels of yields for different horizons (not shown) is very close to unity.

Our examination shows that the central bank interest rate and the yields on bonds of various terms affect each other, in terms of Granger causality. This relation may indicate that these yields are taken into account in the central bank's policy, apparently because they serve as an indicator of expected economic activity. A table describing the results of the tests is given in Appendix 2. Our estimation refers to these relations, as described below.

3.2 Fiscal policy

To describe fiscal policy in the last ten years, we examine three main indices: the government's domestic deficit, the annual deficit targets and the change in them, and the public debt/GDP ratio.

The government's domestic deficit,[9] adjusted for the effect of the business cycle, stood at an average of 4 percent of GDP in the 1990s, albeit with large fluctuations around this level,[10] as presented in Figure 3.

The government deficit used in our estimation is the government's domestic deficit (including credit extended,[11]) adjusted for seasonal factors and the business cycle. The latter adjustment is made because it is reasonable to assume that the price of long-term bonds will be influenced more by the permanent than the current deficit (we examine this hypothesis below). Whereas adjusting for the effect of the business cycle does not make the adjusted deficit a permanent one, it removes an important component, which is perceived by the public as transitory.

Adjustment for the business cycle is made in two ways:

1. By calculating the deficit as the difference between expenditure divided by potential GDP, on the one hand, and non-tax revenue divided by potential GDP and tax receipts divided by actual GDP, on the other.
2. By estimating a model for forecasting the deficit which incorporates various real and financial variables. The model uses the variables included in Brender's (2001) model of tax revenue. The share of the deficit explained by cyclical variables is not expected to affect long-term yields, since this component is perceived by the public as not permanent. By contrast, the other components of the expected deficit—reflecting mainly developments on the expenditure side and structural (and statutory) changes in the composition of income—are likely to affect long-term yields if they are perceived as permanent.

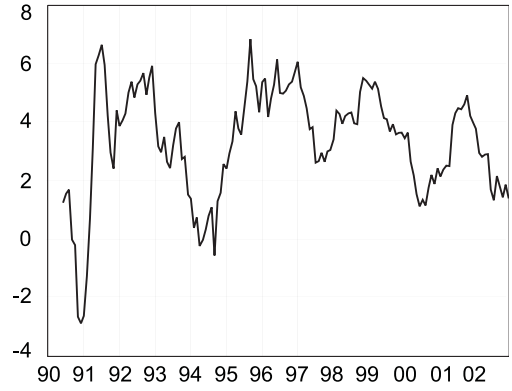
[9] The domestic deficit is used because the deficit in foreign currency was fairly stable in annual terms throughout the period and its changes reflect mainly seasonal shifts which do not always take a fixed path around a fixed level. In order to adjust for this 'noise' we have chosen to focus on the domestic deficit.

[10] Adjustment was made in two ways for the effect of the business cycle. First, it was assumed that potential GDP rises by an average of 4 percent a year, in line with its average growth rate since 1973. Second, it was assumed that per capita potential GDP rises by an average of 1.5 percent a year, also similar to its average growth rate since 1973. The results do not differ significantly whichever estimation is used.

[11] Monthly data for the deficit excluding credit exist only from 1997.

The government's deficit target: in 1991 it was decided to set a declining path for the domestic deficit, against the backdrop of the influx of immigrants and rise in the government deficit. However, these targets were changed several times in the course of the decade, virtually every time a new government was formed. Determining deficit targets for several years in Israel is in line with the trend of setting long-term fiscal targets which developed at that time in the EU and other countries. Nevertheless, a comparison of the development of the actual deficit in Israel with that of those countries shows that the difference between the domestic deficits in Israel and in the EU grew.

Figure 3
The Government Deficit/GDP Ratio Adjusted for Seasonal Factors and the Business Cycle, 1990–2002 (moving 6-month average)



The (net) public debt/GDP ratio fell sharply at the beginning of the decade, subsequently remaining stable until 2000.

4. ESTIMATION AND RESULTS

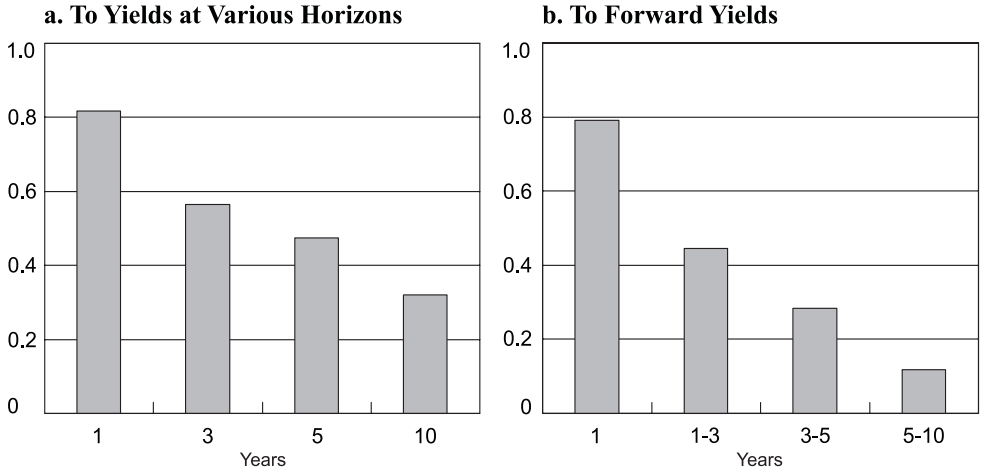
The factors affecting bond yields for various terms are estimated by a set of SUR (Seemingly Unrelated Regression) equations, which adjusts the estimation for a possible correlation between the equations' residuals for the various yields. Since we cannot reject the hypothesis that the yields on bonds for some terms Granger-cause the central bank interest rate, which is an explanatory variable in the equations, we also estimate the system using instrumental variables for the central bank interest, i.e., the 3SLS (Three Stage Least Squares) method. When this method is used the results of the estimation are not significantly different from those obtained using SUR (see tables in Appendices 4.1 and .2).

In order to reflect the different behaviors along the yield curve, we estimate a system of four equations for horizons of one, three, five, and ten years. We estimate the system for yields on bonds and for derived forward yields. Estimating the factors influencing forward yields enables us to identify and isolate the effects of the explanatory factors for sub-periods of long-term bonds.

In accordance with the theoretical framework presented in Section 2, the equations in the system include variables for monetary policy, fiscal policy, interest abroad, and the change in economic activity, as well as several demographic variables. The equations also include a lagged dependent variable to adjust for the serial correlation between yields on bonds. The results of the estimation are given in Tables 4a and 4b. The results of estimating the equations without the lagged dependent variable are similar to those described below, and the explanatory level is also very high, but the existence of the serial correlation requires an estimation that includes the lagged variable.

Monetary policy: the effect of the interest rate is found to be significant for all horizons, but the longer the horizon, the lower the intensity. A one-percentage-point rise in the real monetary interest rate gives rise to a 0.82-percentage-point increase in the yield on one-year bonds and a 0.32-percentage-point rise in that on 10-year bonds (Figure 4). The estimation of forward yields shows that the impact of monetary policy on long-term yields is not only due to the fact that they incorporate short-term yields, but also because monetary policy has a direct and significant effect on the long end, i.e., on expected future yield. A one-percentage-point rise in the real monetary interest rate is expected to be expressed in a 0.28-percentage-point increase in the yield in the fourth and fifth years, and only a 0.1-percentage-point rise (albeit statistically significant) in the expected yield in the sixth through tenth years (Figure 4b). These results attest to the fact that there is a transmission mechanism of the monetary policy that determines both short- and long-term interest rates. In addition, the results indicate that a change in the central bank interest rate, which is set each month, is also perceived as an indicator of longer-term policy, and hence affects expected future interest rates, too. This interpretation is supported by the results of a rolling regression[12] we estimated, which show that the relation between the central bank's short-term rate and long-term rates weakened over time. This may be explained by the fact that as the disinflation process progressed the public gradually became convinced of its chances of success, and hence also believed that the high current interest rates no longer signal high future rates.

Figure 4
The Contribution of Monetary Policy[a]



[a] The expected change in yields (in percentage points) in response to a one-percentage-point rise in the central bank's marginal interest rates.

[12] We estimated the model for a period of 6 years (72 observations), shifting the starting point by one month each time. The first regression was from August 1991 to July 1997 and the last was from January 1995 to December 2001.

These results run counter to the prediction of Segmented Markets theory, that the behavior of long-term investors is not influenced by short-term rates. It may reflect the public's learning curve with regard to the central bank's determination to adhere to the disinflation process, which constituted a change from previous policy.

The decomposition of the real interest rate: we also estimated the equations in a formulation which included the nominal interest rate of the central bank and inflation expectations instead of the real interest rate. The results show that the coefficients of the nominal rate and expectations are similar (with inverse signs). According to the Wald test, the hypothesis that the coefficient of the nominal interest rate is equal to that of inflation expectations, for all terms, cannot be rejected.

In order to identify the effect on yields of expected future—as well as actual—monetary policy, we tried to incorporate indicators of expected monetary policy in the equations. The first of these is the difference between yields on unindexed 1-year bonds and the central bank interest rate. A positive difference, with bond yields above the interest rate, attests to expectations that the interest rate will rise in the coming year (up to a term premium). The addition of this variable does not improve the quality of the estimation or the equation's forecasting ability. Another variable we examine is the residual of the central bank interest rate equation[13] (Taylor Rule), as this represents the unexpected element of the central bank interest rate. When the residual is positive, i.e., actual interest is higher than expected, the interest rate is expected to fall in the future, so that a positive residual should contribute to lower yields for long terms. The effect of this variable is significant for terms of five to ten years, but not for shorter terms. In this instance, too, there was no substantial change in the results of the estimation of the system or any improvement in the forecasting ability of the equations. We also tried to include a variable for significant interest rate changes in the equations, such as interest-rate squared or a dummy variable taking the value +1 or –1 for interest-rate changes greater than 1 or smaller than –1, but they were not found to be significant. An attempt to examine the effect of monetary interest separately for periods when the central bank raised the interest rate as opposed to periods when it lowered it did not produce significant results.

Fiscal policy: in the main specification of the system of equations fiscal policy is represented by three explanatory variables: the expected cyclically adjusted domestic deficit, the deficit target, and the influx of immigrants.

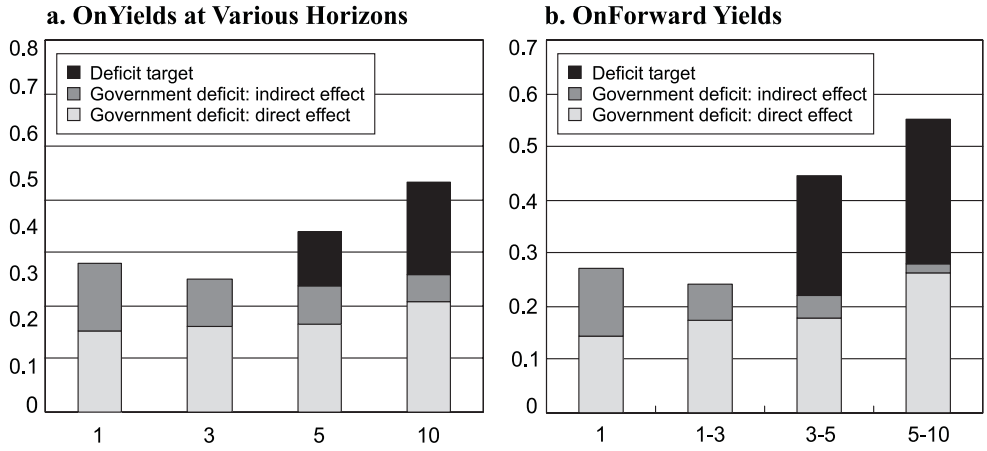
The effect of the variable for the expected deficit (adjusted for seasonal factors and the business cycle) is found to be significant for all yield terms. The effect of a rise of 1 percent of GDP in the deficit ranged from 0.15 for yields of up to a year to 0.21 for 10-year yields (Figure 5a). As expected,[14] the effect of the budget deficit on long-term yields was found to stem primarily from the contribution of the long end and not from that of the short end. A rise of one percent of GDP in the deficit is expected to increase the yield from the sixth to the tenth years by 0.26-percentage points (Figure 5b). The effect of the actual deficit, which is not adjusted for the business cycle, was not significant. Moreover, including the deficit (whether cyclically adjusted or not) for a period that includes both the future and the past—or just the past—did not produce significant results. In view of possible reservations concerning the computation of the cyclically adjusted deficit, we examined the result that

[13] The results of the estimation of the equation are presented in Appendix A1.

[14] See, for example, the findings of Wachtel and Young (1987).

only the permanent deficit affects yields by calculating the cyclically adjusted deficit in another way. We estimated an equation for the government deficit (Appendix 3.1) which included cyclical variables, such as GDP and wages.

Figure 5
The Effect of Fiscal Policy[a]



[a] The expected change in yields (in percentage points) in response to a rise of one percent of GDP in the government's cyclically adjusted domestic deficit, and in the deficit target.

We use the residuals of this equation, which represent the non-cyclical part of the deficit, as an alternative way of measuring the cyclically adjusted deficit, and find that only that part of the deficit influences yields, while its cyclical part (the deficit explained by the equation) has no effect on them. The results also show that it is expected rather than actual behavior that is pertinent with regard to yields. This is particularly the case because information about the past is expected to be reflected in the lagged yield, which is also included in the equation. These findings are similar to those of Feldstein (1986) for the US.

Additional information on which the public can base its expectations regarding the future deficit is the government's *deficit target* for the next few years. This applies if the government's decisions are perceived as credible. With respect to one-year yields we include the target for the coming year; for longer yields we have included the target for three years ahead. We do not incorporate targets for longer terms because their credibility seems to us to be lower and because they are not available for some of the estimation period. The effect of the target on yields is found to be significant only for long horizons—five and ten years. The coefficient for the target is not significantly different in these horizons from that for the deficit, and is significant in the equations in which it is included even when this is done in addition to the deficit; removing it does not alter the coefficient of the deficit.[15]

We also include the *influx of immigrants in the last six months*. The rise in the deficit due to the cost of absorbing immigrants is expected to have only a slight effect on long-term yields, because a deficit of this kind should be temporary and 'cyclical' to some extent. The monthly rate at which new immigrants reached Israel accelerated in the early 1990s, peaking

[15] When we included the target for the next year in the equation for the yield between the first and third years, its effect was not significant.

at about 20,000 in mid-1991, contracting at the beginning of 1992 to 6,000, to less than 4,000 in 2001. The influx of immigrants was found to have a negative and significant effect on yields for three, five, and ten years.

An important variable used in the literature for describing fiscal policy is the *public debt*. Although there are reasons for expecting the debt (especially net debt adjusted for government loans to the public) to influence yields, because of the risk premium and a shortage of sources for private-sector investment, our various attempts using different definitions of the debt do not indicate a relationship of this kind. As noted above, this result is consistent with findings based on time series data for other countries. In addition to the

Table 4a
Results of Estimation for Bond Yields

	B1	B3	B5	B10
Intercept	0.336	0.579	0.630	0.559
	1.15	3.19	4.16	4.13
Real central bank interest rate	0.358	0.229	0.169	0.092
	13.80	14.86	13.66	9.57
Expected deficit	0.067	0.069	0.059	0.059
	2.33	3.46	3.80	4.97
Change in GDP	6.969	3.685	2.120	1.359
	2.64	2.33	1.89	2.29
US interest (from 1998)	–0.02	0.055	0.046	0.034
	0.86	2.51	2.55	3.05
Deficit target for next year	–0.08			
	1.40			
Deficit target for 3 years	0.013	0.036	0.049	
	0.69	2.14	3.18	
Influx of immigrants	–0.012	–0.035	–0.034	–0.025
	0.47	–2.55	3.12	2.95
Influx of immigrants(-30)	0.022	0.016	0.011	0.008
	2.23	2.60	2.23	2.06
Lagged dependent variable	0.562	0.595	0.640	0.713
	17.20	19.97	23.73	26.59
R^2	0.953	0.970	0.973	0.975
DW	1.70	1.42	1.36	1.43
N	125	125	125	121

* Values in small font are t-values

Note: *Bx* is the gross yield to maturity on CPI-indexed government bonds for *x* years; the real central bank interest is the nominal interest *less* 12-month inflation expectations; expected deficit is the moving average of the government deficit, adjusted for seasonal factors and the business cycle, six months ahead; the change in GDP is in log form and seasonally adjusted. In columns 1 to 3 the change in GDP is in the last three months, and in column 4 it is for the last six months; US interest is the yield on US government T-bonds for *x* years, adjusted for inflation for the same number of years (in the past) *times* a dummy with value 1 in 1998 and subsequently; the influx of immigrants is calculated as the moving average of the last six months.

Table 4b
Results of Estimation for Forward Yields

	F1	F1_3	F3_5	F5_10
Intercept	0.554	0.676	0.851	0.620
	1.66	3.26	3.57	3.25
Real central bank interest rate	0.352	0.163	0.092	0.029
	12.98	10.42	5.46	2.69
Expected deficit	0.065	0.063	0.058	0.065
	2.23	3.19	2.76	4.57
Change in GDP	8.531	3.260	0.967	1.940
	2.70	1.58	0.43	1.91
US interest (from 1998)	–0.022	0.075	0.049	0.035
	0.65	2.59	1.74	2.95
Deficit target for next year	–0.158			
	1.87			
Deficit target for 3 years		0.018	0.073	0.067
		0.65	2.19	2.78
Influx of immigrants	–0.003	–0.037	–0.048	–0.030
	0.11	2.52	2.96	2.82
Influx of immigrants (–30)	0.019	0.013	0.004	0.005
	1.81	2.00	0.62	1.08
Lagged dependent variable	0.555	0.634	0.675	0.751
	14.97	15.59	14.57	18.35
R^2	0.953	0.962	0.930	0.946
DW	1.71	1.54	2.06	1.99
N	125	125	125	121

* Values in small font are t-values.

Fx_y is the gross future yield to maturity from year *x* to year *y* on indexed government bonds; the real central bank interest is the nominal interest less 12-month inflation expectations; expected deficit is the moving average of the government deficit, adjusted for seasonal factors and the business cycle, six months ahead; the change in GDP is in log form and seasonally adjusted. In columns 1 to 3 the change in GDP is in the last three months, and in column 4 it is for the last six months; US interest is the yield on US government T-bonds from year *x* to year *y*, adjusted for inflation for the same number of years (in the past) *times* a dummy with value 1 in 1998 and subsequently; the influx of immigrants is calculated as the moving average in the last six months.

debt/GDP ratio,[16] which has a downward trend, especially in the first half of the decade, we also tried to include short-term deviations of the debt from its trend.[17] These are found to be positive and significant, as expected (i.e., a positive deviation from the declining trend serves to raise yields), but the variable served to crowd out the deficit target variable (and that for immigrants with a 30-month lag). This may indicate that the current deviation from the trend of the debt is perceived as being long-term, and hence replaces the expected deficit target for the next few years. Note that the debt figures we use were measured annually for

[16] The net and gross debt (excluding government credit to the public) and the domestic debt.

[17] The deviations were derived alternatively from the trend using the HP procedure, from a linear trend and from a squared trend.

most of the period, and so are less appropriate for describing the effect of the size of the debt on the interest rate.

The *indirect effect of fiscal policy via monetary policy*: Fiscal policy may also have an indirect effect on yields through monetary policy, i.e., when setting its interest rate, the central bank also takes the development of fiscal variables into account. This hypothesis has been posited in several recent studies, where it is claimed that monetary policy cannot attain the price-stability target without relating to fiscal policy, and that in addition to the Taylor Rule, monetary policy must also consider the targets connected with the government deficit (Woodford, 2001).

An empirical examination of the relation between fiscal shocks and monetary policy is presented in Canzoneri, Cumby and Diba (2002) by means of an SVAR system which includes fiscal variables—government expenditure and taxes, real economic activity, prices, central bank interest rates, long-term interest rates, and the banks' reserves. The correlations thus obtained indicate that even if the central bank's response is formulated in terms of the Taylor Rule, which includes only activity and prices, since the latter are influenced by fiscal policy (government expenditure), in the final event the government's behavior does impact on monetary policy. They also show that in the framework of the system they estimated, government behavior also has a direct effect on the central bank's interest rate and this is similar in extent to its indirect influence.[18]

To test the hypothesis that monetary policy is influenced by fiscal developments, we estimate an equation for the central bank's interest rate (see Appendix 1). According to the equation, the interest rate is determined by the difference between inflation expectations and the inflation target, as well as by the level of inflation in the preceding year, economic activity, and interest rates abroad. The equation also incorporates a smoothing factor, which is the lagged interest rate. The government's expected cyclically adjusted deficit for the next six months, as represented in the long-term yield equation, does not have a direct effect on monetary policy decisions. However, even though the central bank does not examine the development of the deficit directly, the deficit may influence the development of inflation expectations, and since these are taken into account when the central bank sets interest rates, the deficit impacts indirectly on rates. Estimating the equation for the development of inflation expectations does in fact bear out this hypothesis (Appendix 1), and we find that the expected deficit has a positive effect on the public's inflation expectations. The indirect effect of the deficit via expectations is expressed in nominal interest-rate changes, due to the central bank's response to expectations, as well as in actual expectations, which determine the real interest rate. In general, this can be written as follows:

(9)

$$
\begin{aligned}
R_m &= \alpha_0 + \alpha_1 R_{MON} + \alpha_2 SG = \alpha_0 + \alpha_1 (i - \pi^e) + \alpha_2 SG \\
&= \alpha_0 + \alpha_1 ((\beta_0 + \beta_1 \pi^e) - \pi^e) + \alpha_2 SG = \alpha_0 + \alpha_1 (\beta_0 + (\beta_1 - 1)(\gamma_0 + \gamma_1 SG)) + \alpha_2 SG \\
&= \left(\alpha_0 + \alpha_1 (\beta_0 + \gamma_0 (\beta_1 - 1))\right) + \left(\alpha_2 + \alpha_1 (\beta_1 - 1)\gamma_1\right) SG = \delta_0 + \delta_1 SG
\end{aligned}
$$

[18] Examination of the effect of a change in taxes on monetary policy did not give unequivocal results.

where Rm is the yield on bonds, RMON is the central bank's real monetary interest, SG is the expected government deficit, and πe is inflation expectations. The constant term in the equation represent all the other explanatory variables.

The magnitude of the indirect effect of the deficit on real interest rates depends on three factors: the extent to which short-term rates influence long-term ones (α1), the extent to which the central bank adjusts the interest rate *beyond* the rise in expectations (β1-1), and the impact of the deficit on inflation expectations (γ1). The direct and indirect effect of the deficit on real long- and short-term interest rates[19] is shown in the following table.

Table 5
Overall Effect of Deficit on Real Interest Rates

Horizon (years)	Direct effect of deficit	Indirect effect[a]	Total effect
1	0.153	0.129	0.282
3	0.170	0.088	0.258
5	0.163	0.074	0.237
10	0.206	0.050	0.256

[a] Product of the effect of the deficit on the central bank's real interest rate (0.157) and the coefficient of this variable in the interest-rate equation for the appropriate term.

From Table 5 and Figure 5 it can be seen that even though the direct effect of fiscal policy grows as the interest-rate horizon gets longer, because the influence of the central bank rate is greater for shorter terms, the additional impact of the deficit via monetary policy increases in shorter terms, so that the overall impact of fiscal policy is similar for all terms—about 0.25.

Interest abroad: we include the real yield on US government bonds for terms equivalent to those of domestic bonds in the equation in order to learn how interest rates abroad affect yields on domestic bonds. Since the yield on foreign bonds is nominal, it is necessary to adjust for inflation expectations in the US for the relevant period. We choose to deduct actual past inflation for a period equal to the term of the bond, from its yield, assuming that inflation expectations over a longer horizon will be based on the average over a longer period in order to smooth short-term fluctuations and expectations. In an alternative specification we incorporate the one-year dollar interest rate for all terms. Ten-year CPI-indexed bonds were issued for the first time in the US in 1997. Since then they have been issued annually, so that a series of real yields to redemption for terms of between nine and ten years exists.[20] Hence, for the ten-year yield we used the real yields obtained on these bonds,[21] and also for calculating the forward interest rate of between five and ten years.

An attempt to include this rate for the entire period or partial periods was not successful, other than the formulation that incorporates this interest rate from 1998.[22] The liberalization of the Israeli economy was a lengthy process which took place primarily in the 1990s, and

[19] In the long run, i.e., taking into account lagged effects.

[20] The term to maturity grows shorter during the year until a new series is issued.

[21] Since in the final event interest abroad is included in the equations only from 1998 (via a dummy variable), we could use this series.

[22] The dummy variable for a year was also included in the equation separately from the interest-rate variable, but since it was not significant it was dropped from it.

the results of the estimation attest to the fact that the alternative interest rate abroad became relevant only towards the end of the decade, and even then only partly. The coefficient of the yield on US government bonds is statistically significant but small for terms of three, five and ten years. This could be because of the tax discrimination that still existed (in the sample period) regarding investments in assets abroad,[23] and the tendency to invest in domestic assets due to the greater accessibility of information about them ("home bias"). An attempt to enable the coefficient to change after 1998 by multiplying the time trend or adding a dummy variable for the period after 2000 did not produce significant results. We also include interest rates abroad in the central bank interest-rate equation (A1), and find that it has had a significant impact on monetary policy since 1998.[24] Consequently, the total direct and indirect effect of interest rates abroad on bond yields is relatively great and predominantly indirect.

Together with the interest rate abroad, we also tried to include an indicator of the country risk premium, using two alternative estimations. The first is an aggregate index of the risk premium of emerging markets, calculated as the difference between the yield on these countries' bonds and that on US bonds.[25] The second is an index of a country's financial reputation, as published by Institutional Investor.[26] These variables were not significant in the estimation, despite the expectation that country risk will be expressed in domestic bond yields.

Change in GDP: an acceleration in the GDP growth rate increases demand for investment, according to the accelerator theory and hence is expected to raise the yield on bonds. The GDP data we use constitute a smoothing to monthly frequency of seasonally adjusted quarterly data at constant prices. Our estimation uses a moving 3- or 6-month average of this variable. The effect of this variable is significant in both the yield equations and the estimation of forward yields. We tried to include the deviation of actual from potential GDP in the set of equations,[27] but its influence is not significant.

The effect of the rise in investment due to immigration: we also include a variable for the influx of immigrants, with a two-and-a-half-year lag (in addition to the number of immigrants with a six-month lag, reflecting the perception of the deficit at the time of the influx), in order to give expression to the effect of immigrants' demand for housing, as well as of their absorption in employment, on the demand for investment goods, and hence on yields. As expected, the results are that this variable has a positive and significant effect on yields for all terms, although at certain specifications it is not significant.

Other variables which we incorporated within the estimation and are not found to be significant include the standard deviation of the exchange rate and the change in the exchange rate, as indices of uncertainty which could lead to a demand for a higher risk

[23] Individuals were liable for tax on both CPI-indexed bonds and assets abroad, while institutional investors were liable for tax only on assets abroad, so that there was discrimination against assets abroad during the sample period.

[24] The coefficient for the long-term foreign interest rate in the Bank of Israel's interest-rate equation is unity (see Appendix A).

[25] This index is calculated by J.P.Morgan.

[26] The index reflects the weighted average of the marks obtained in an extensive survey of about 100 banks throughout the world, and is published semi-annually.

[27] This variable is I(0).

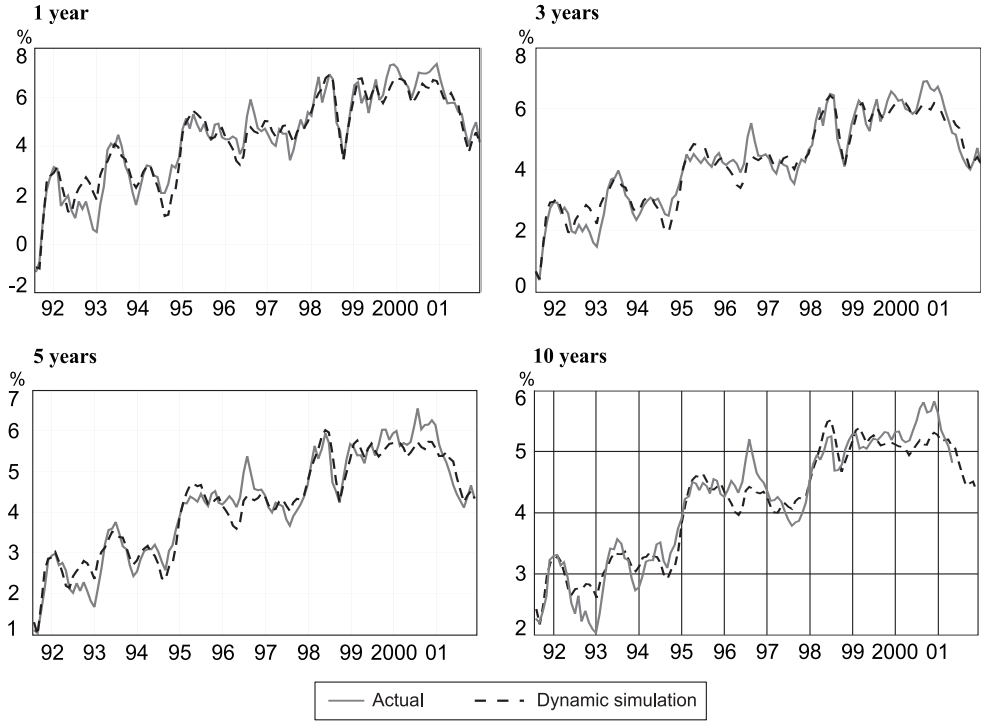
premium, namely, higher yields on indexed bonds. We also attempted to include financial variables: total monthly borrowing by the government, which could be expected to act to raise the interest rate and the relative stock of all bonds.

4.1 Stability tests

Dynamic simulation: to examine the quality of the estimation we ran a dynamic simulation of the system for bond yields for one, three, five, and ten years. In other words, we solved the values of the dependent variables while substituting their lags, as they were solved in the preceding period (and not their true value). The results are presented in Figure 6.

As the figure shows, the simulation fits the actual yields very well, and in most periods it succeeds in shadowing trend changes in yields. The results for the yields on ten-year bonds are slightly less precise, and it appears that the simulation shadows the direction of the changes, but not their intensity.

Figure 6
Actual Yields and Dynamic Simulations, 1992–2002



4.2 Analysis of the contributions of fiscal and monetary policy to interest rates

The results of the equations presented above may be used to examine the relative contributions of several variables—especially monetary and fiscal policy—to explain the variance of long-term interest. The analysis was based on decomposing the explained variance of long-term interest into the variance deriving from each of the explanatory variables, adjusted for the size of its coefficient in the equation.[28]

As Table 6 shows, the variance of monetary policy, as expressed in the volatility of real monetary interest, contributes 70 percent of the total variance of long-term yields, while the three components of fiscal policy contribute about 20 percent in the entire period. The relatively large contribution of monetary interest rates to long-term yields stems from two factors: a relatively large coefficient and the fact that expected real interest rates soared in the course of this period, when the disinflationary policy was implemented.

Table 6
The Contribution of Economic Factors to Explaining the Variance of the Yield on 10-Year Bonds (Share of Total)[a]

	Monetary policy	Fiscal policy			Other variables		
	Expected real monetary interest	Expected deficit/GDP	3-year deficit target	Change in influx of immigrants in last 6 months	Change in GDP	Interest abroad	Change in influx of immigrants with two-and-a-half-year lag
1991.08–2001.12	0.69	0.09	0.02	0.10	–0.01	0.16	–0.04

[a] The contribution of each variable to total variance includes its covariance with the other explanatory variables. As a result, there may be negative values, as shown in the table.

5. CONCLUSION

The principal finding of this study is that both fiscal and monetary policy influence real yields. We find that the direct effect of fiscal policy is greater on long-term than on short-term yields. A one-percent of GDP rise in the deficit increases the real interest rate on 10-year bonds by about 0.2 percentage points. These results apply to the share in GDP of the cyclically adjusted deficit expected in the next six months. We also find that without this adjustment the deficit does not affect bond yields, possibly because some of it (a large part, according to the results presented in Appendix 3.1) reflects cyclical changes – which

[28] The covariance of each explanatory variable with the other variables is included in the contribution of the variable in question to the explained variance.

are perceived as transitory. In addition, the deficit in the past (in the last six months at any point in time) does not affect yields significantly, i.e., the public's expectations regarding the deficit can be described as rational rather than adaptive. Alongside the actual deficit, the deficit target also influences interest rates, and if it rises so do yields, particularly in the medium and long run. The coefficient of the deficit target is similar to that of the actual deficit. An examination of the effect of the debt/GDP ratio shows that it does not have a significant effect on yields, and this bears out the result of similar studies undertaken for other countries (Kitchen, 1996; Caporale and Williams, 2002), although deviations from the debt trend (which is negative in the ten-year-period examined) have the expected (positive) impact on yields. We also find that the deficit has an indirect effect on yields in the money market, via its impact on monetary policy (through influencing the public's inflation expectations). This attests to the relation between fiscal and monetary policy. The response of real yields to changes in government saving indicates that the public does not fully adjust its saving rate to that of the government. If changes in government saving are perceived as permanent, this result may be interpreted as evidence that Ricardian equivalence does not exist in full in Israel.

Monetary policy has a marked impact on short-term yields but also affects long-term yields. Although the extent of its influence declines as the term of the interest rate increases, its effect on long-term yields is not inconsiderable either: a one-percentage-point rise in expected real interest (the central bank interest rate less inflation expectations) contributes a 0.3-percentage-point to the yields on ten-year bonds. Most of the effect of the expected monetary short-term interest rate on long-term yields is because the latter reflect an average of yields for all terms, including short ones, but it is also due to the direct impact of monetary interest rates on long-term yields (i.e., on the future component of the yield). This may reflect the fact that even though the monetary policy instrument—the interest rate—is a short-term one, in the context of the adoption of inflation targets at the beginning of the decade, when the inflation rate was high, and the declared central bank policy of convergence to price stability, the public assumed that this policy would be maintained in the long run, so that it also influenced long-term interest rates (beyond its effect via short-term interest).

APPENDIX 1

1. The central bank's interest-rate equation

$$(10)\quad i = \underset{5.66}{2.15} + \underset{8.44}{0.28}(\pi_{t-1}{}^{e} - \pi^*) + \underset{1.76}{0.06}\,\pi 12_{t-1} + \underset{2.04}{0.0663}\,MA((Y_{t-3} - Ypot_{t-3})/Ypot_{t-3}, 6)$$
$$+ \underset{2.74}{0.24}\,US1 * D97aft - \underset{3.37}{1.61}\,D97aft + \underset{21.6}{0.77}\,i_{t-1}$$

Sample: 1992.1-2001.12

* Values beneath coefficients are t-values.

i — Bank of Israel nominal marginal interest;

(11) $(\pi_{t-1}{}^{e} - \pi^*)$ — gap between expected inflation (derived from capital market) and inflation target;

$\pi 12_{t-1}$ — inflation in last 12 months;

US1 — nominal 12-month yield in US;

(12) $MA((Y_{t-3} - Ypot_{t-3})/Ypot_{t-3}, 6)$ — moving average of gap between actual and potential GDP, with a 3-month lag;

D97aft — dummy variable = 1 from 1998.

2. Inflation expectations equation

$$(13)\quad \pi_t^{e} = \underset{3.97}{2.06} + \underset{1.92}{0.11}\,MA(GDEF\_YA_{t+6}, 6) - \underset{1.74}{0.07}\,MA(i_{t-2}, 2) - \underset{3.58}{1.19}\,D97aft + \underset{15.8}{0.85}\,\pi_{t-1}{}^{e}$$

Sample: 1992.1-2001.12

* Values beneath coefficients are t-values.

π_t^{e} — Inflation expectations derived from capital markets.

(14) $MA(GDEF\_TA_{t+6}, 6)$ — 6-month moving average of deficit adjusted for seasonal factors and business cycle, for 6 months ahead.

(15) $MA(i_{t-2}, 2)$ — 2-month moving average of Bank of Israel interest with two-period lag

D97aft — dummy variable = 1 from 1998.

APPENDIX 2

Test of Granger Causality between Central Bank Interest and Yields on Bonds of Various Terms

	Null hypothesis (6 lags)	
Yield horizon	*ir* does not Granger-cause B	B does not Granger-cause *ir*
1	3.6*	1.7
3	3.9*	2.0**
5	3.2*	2.7*
10	2.8*	3.6*
1–3	3.6*	1.1
3–5	3.2*	2.7*
5–10	1.2	1.9**

*The null hypothesis can be rejected at the 5% confidence level;
**The null hypothesis can be rejected at the 10% confidence level.
ir: the monetary interest set by the central bank *less* inflation expectations.
B: the yield on government bonds, in accordance with the horizon denoted.

APPENDIX 3.1

Cyclical Factors Affecting the Government's Domestic Deficit: Estimates of the Government's Domestic Deficit Including Credit, Seasonally Adjusted

Dependent variable:expected deficit in next six months	
Explanatory variable	Coefficient
Intercept	73.303
	8.04
GDP	–0.154
	3.29
GDP with 13-month lag	–0.671
	9.61
GDP with 6-month lag	0.435
	6.01
Total bank foreign-currency credit	0.245
	8.89
Sale of apartments in last 3 months	0.208
	1.66
Sale of apartments in last 7 months, with one-year lag	–0.659
	4.09
Average wage per employee post, in last 8 months	–2.485
	2.87
Average wage per employee post, in last 12 months, with 15-month lag	–5.030
	3.30
Consumer goods imports in last 3 months	–3.886
	3.94
Real change in General Share-Price Index	–0.161
	13.84
Sale of shares abroad by Israeli parties at interest	–0.588
	4.32
R^2	0.812
DW	1.426
N	125

Note: All the variables are in terms of moving averages. The government's domestic deficit, including credit, as a percentage of GDP, is seasonally adjusted; gross GDP is in NIS billion at 2000 prices; total bank credit in or denominated in foreign currency is in NIS billion at 2000 prices; sales of new apartment are in thousands; the average wage per employee post is in NIS thousand at 2000 prices; consumer goods imports are in NIS billion at 2000 prices; the real change in the General Share-Price Index of the Tel Aviv Stock Exchange is in points; sales of shares abroad by Israeli parties at interest includes mergers and is in NIS billion, at 2000 prices.

APPENDIX 3.2

Results of Estimation of Bond Yields with Deficit Equation

	B1	B3	B5	B10
Intercept	0.825	0.833	0.838	0.642
	2.46	3.82	4.51	3.96
Real central bank interest rate	0.348	0.223	0.165	0.091
	13.14	14.03	12.87	8.93
Expected deficit (estimate)	–0.033	–0.009	–0.006	0.010
	1.00	0.41	0.33	0.70
Unexpected deficit	0.008	0.053	0.050	0.048
	0.16	1.60	1.86	2.28
Change in GDP	6.08	2.93	1.47	0.962
	2.15	1.74	1.24	1.50
US interest (from 1998)	–0.046	0.040	0.031	0.023
	1.49	1.62	1.62	1.99
Deficit target for next year	–0.087			
	1.44			
Deficit target for 3 years		0.022	0.043	0.058
		0.94	2.19	3.29
Influx of immigrants	–0.006	–0.028	–0.029	–0.021
	0.20	2.02	2.58	2.31
Influx of immigrants(-30)	0.004	0.004	0.001	0.001
	0.42	0.67	0.22	0.14
Lagged dependent variable	0.569	0.615	0.662	0.748
	16.37	20.29	24.42	27.56
R^2	0.951	0.967	0.971	0.972
DW	1.59	1.33	1.27	1.30
N	125	125	125	121

* Values in small font are t-values.

Note: Bx is the gross yield to maturity on x-year CPI-indexed government bonds; the central bank's real interest is the 12-month nominal interest adjusted for inflation expectations; the expected deficit is estimated from the equation in Appendix C1; the unexpected deficit is the part that is not explained by the equation in Appendix C1; the change in GDP is in log terms and seasonally adjusted. In columns 1–3 the change in GDP is in the last 3 months, and in column 4 it is in the last 6 months; the US interest is the yield on US government bonds for x years, adjusted for inflation during that number of years (in the past) times a dummy variable that takes the value 1 from 1998; the influx of immigrants is the moving average in the last 6 months.

APPENDIX 4.1

Results of 3SLS Estimation for Bond Yields

	B1	B3	B5	B10
Intercept	0.147	0.533	0.629	0.615
	0.48	2.81	3.83	4.10
Real central bank interest rate	0.444	0.271	0.221	0.139
	12.30	14.04	13.47	10.35
Expected deficit	0.076	0.068	0.062	0.064
	2.47	3.47	3.69	4.74
Change in GDP	6.19	2.99	1.48	0.894
	2.31	1.89	1.31	1.43
US interest (from 1998)	–0.042	0.053	0.039	0.027
	1.38	2.33	2.02	2.12
Deficit target for next year	–0.069			
	1.16			
Deficit target for 3 years		0.014	0.039	0.057
		0.71	2.21	3.39
Influx of immigrants	–0.012	–0.032	–0.033	–0.024
	0.44	2.25	2.76	2.42
Influx of immigrants(-30)	0.031	0.020	0.015	0.010
	2.78	2.97	2.55	2.13
Lagged dependent variable	0.505	0.557	0.584	0.647
	14.04	18.47	20.60	22.30
R^2	0.947	0.967	0.968	0.967
DW	1.54	1.31	1.22	1.24
N	125	125	125	121

* Values in small font are t-values.

Note: *Bx* is the gross yield to maturity on x-year CPI-indexed government bonds; the central bank's real interest is the 12-month nominal interest adjusted for inflation expectations; the expected deficit is a moving average of the government deficit, adjusted for seasonal factors and the business cycle, six months ahead; the change in GDP is in log terms and seasonally adjusted. In columns 1–3 the change in GDP is in the last 3 months, and in column 4 it is in the last 6 months; the US interest is the yield on US government bonds for *x* years, adjusted for inflation during that number of years (in the past) *times* a dummy variable that takes the value 1 from 1998; the influx of immigrants is the moving average in the last 6 months.

The instrumental variables for the central bank interest rate are all the exogenous variables in the equation, the lagged monetary interest, the deviation of inflation expectations from the inflation target, inflation in the last year, and potential GDP.

APPENDIX 4.2

Results of 3SLS Estimation for Forward Yields

	F1	F1_3	F3_5	F5_10
Intercept	0.716	0.969	0.675	0.391
	3.47	14.81	3.22	1.13
Real central bank interest rate	0.435	0.183	0.168	0.080
	10.98	9.01	7.14	5.29
Expected deficit	0.078	0.066	0.065	0.074
	2.47	3.25	2.81	4.67
Change in GDP	8.415	3.058	0.656	1.24
	2.61	1.49	0.28	1.16
US interest (from 1998)	–0.037	0.075	0.026	0.024
	1.06	2.56	0.88	1.84
Deficit target for next year	–0.141			
	1.70			
Deficit target for 3 years		0.016	0.077	0.077
		0.57	2.24	3.07
Influx of immigrants	–0.008	–0.036	–0.051	–0.024
	0.25	2.40	2.83	2.03
Influx of immigrants(-30)	0.027	0.015	0.007	0.006
	2.38	2.18	0.86	1.10
Lagged dependent variable	0.494	0.611	0.569	0.666
	11.74	14.81	11.24	15.49
R^2	0.948	0.961	0.915	0.933
DW	1.55	1.49	1.78	1.70
N	125	125	125	121

* Values in small font are t-values.

Note: *Fx_y* is the gross future yield to maturity from year *x* to year *y* on indexed government bonds; the real central bank interest is the nominal interest *less* 12-month inflation expectations; expected deficit is the moving average of the government deficit, adjusted for seasonal factors and the business cycle, six months ahead; the change in GDP is in log form and seasonally adjusted. In columns 1 to 3 the change in GDP is in the last three months, and in column 4 it is for the last six months; US interest is the yield on US government T-bonds from year *x* to year *y*, adjusted for inflation for the same number of years (in the past) *times* a dummy with value 1 in 1998 and subsequently; the influx of immigrants is calculated as the moving average in the last six months.

The instrumental variables for the central bank interest rate are all the exogenous variables in the equation, the lagged monetary interest, the deviation of inflation expectations from the inflation target, inflation in the last year, and potential GDP.

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